

Bind in

EXETER HALL

LECTURES

*THE POWER OF GOD
IN HIS
ANIMAL CREATION.*



BY
PROFESSOR RICHARD OWEN,
D.C.L., F.R.S.

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The Aye-aye. (*Chiromys Madagascariensis*.)

2

Instances of the Power of God as
Manifested in
His Animal Creation.

A LECTURE

BY

PROFESSOR RICHARD OWEN, D.C.L., F.R.S.



B

1864

ON SOME
INSTANCES OF THE POWER OF GOD
AS
MANIFESTED IN HIS ANIMAL CREATION.

OF the Course of Lectures arranged for the present season, I commence this evening the Introductory one, allotted to me by your Committee.

When I was honoured by their request to perform this task, I begged hard to be excused, pleading the pressure of analogous labour, and a sense of failing elasticity and power of thought, through a strain upon faculties never of the strongest, and which have been exerted in the museum, the study, the dissecting-room, and lecture-theatre, almost unintermittingly for more than thirty years.

It is a natural desire—a weakness of the flesh—to prefer one's own fireside, after a day of routine labour, to bracing up the tired powers in the endeavour to satisfy the keen appetite for knowledge of a youthful audience with an hour's supply of intellectual provender.

But you have banded yourselves together under the designation of a Christian Association, thereby giving public pledge to exemplify, in life and labour, the principles of our common creed, and the precepts of its Divine Founder. I could not, therefore, ground a refusal on a plea which centred in mere ease to self. If you, each after his daily

task,—longer it may be—drier, more wearisome, I think it must be—than mine,—have been willing to forego the quiet pleasures of home, and a choice of the many recreations and excitements to which a metropolis invites and tempts, preferring to gather yourselves together in this place and goodly company, for the higher aim of mental improvement and the acquisition of truth, surely it was not for me to hold back.

And then another consideration stirred within me. Your Association seems seldom to be addressed by men of science. In glancing down the present list of Lectures, I find myself the only layman : and yet the so-called “man of science,” if he deserve the name, ought to be the possessor of certain parcels of indisputable truth ; and he should be able to impart to you some of this most precious commodity.

There have, indeed, been times when the Christian church has been unwilling to receive it ; but I trust to be able to show, by the example of such times, that a like jealousy of natural knowledge is without ground, and unworthy of any body of sincere worshippers of the Author of all truth.

For what is that “Natural Knowledge,” of the Society for Promoting which I am a member ?* It is, as our “Philosophical Transactions” have shown for two centuries past, the interpretation of the Creative Power, as manifested in those properties and phenomena of God’s universe which we ourselves have been created with capacities, in different degrees, according to the individual, of interpreting. The comprehension of creation has been ordained to be the result and reward of the right exercise of the faculties of investigation and discovery.

And now, by God’s mercy, we know that such faculties or talents are intrusted gifts, for the use of which we are responsible.

It has been revealed to us, that it is “He that hath

* The Royal Society for the Promotion of Natural Knowledge.

made us, and not we ourselves :” we are debtors, therefore, for every power and faculty with which we can energize. As our great Christian Poet writes,—

“ God doth not need man’s works or His own gifts ;
Who best bear His mild yoke, they serve Him best.”

And Christ teaches that part of that yoke is accountability for the gifts so allotted. So, it is under the sense of that accountability that every Christian philosopher employs his faculties of research and discovery in making known the Power of God, a knowledge of which, as well as of the Word, is essential to the avoidance of error.

When the subtle scribes, learned in their Scriptures, which they deemed final and all-sufficient, tempted our Lord, remember what he replied :—“ Ye do err, not knowing the Scripture, nor the power of God.” (Matt. xxii. 29.) And what is this Power? The beautiful Canticle which forms part of the Anglican Liturgy sets it forth most strikingly in its various manifestations :—

The heavens and heavenly orbs : the all-pervading subtle forms of force which the “lightnings, heat, and light” make palpable to sense : “the earth, with the green things thereon, and the beasts of the earth :” the “seas and floods, with the whales, and all that move in the waters :” the “winds and clouds,” with the fowls that soar in the air : the “holy and humble men of heart”—best of created products here, and the preparatory stage to “the spirits and souls of the righteous,” in a higher sphere :—all these “Powers of the Lord” are invoked in the wrapt utterance of the devout singer to “bless the Lord, praise Him and magnify Him for ever !”

Of all the manifestations of Creative Power, those afforded by living things affect our finite apprehension soonest and strongest with a sense of the directness of the Maker’s operations.

The more we investigate the structures, and the clearer

we comprehend their working, the more we are struck by the perfection and purpose of the work.

The complexity is such, the interplay and mutual adjustment of the parts of the organ so exact, the finish of each constituent tissue to its minutest fibre so surpassingly excellent, that we instinctively adore as we trace the Divine Handiwork.

If we think to contrast, under the microscope, the finest filament, or tissue, or polished needle-point of human fabrication, we are humbled by the revelation of its coarseness.

The analogy of the animal organs and systems of organs to the machines of man's invention is, however, so close, that, comprehending and admiring the rare degree of constructive skill, foresight, and purposive adaption, in many artificial machines, the healthy intellect, studying the more refined and perfect natural structures, cannot but conceive therein the exercise of like faculties in a transcendently higher degree. Such a mind, therefore, instinctively, inevitably, rises to admiration of such transcending power; and feeling within itself the beneficial working of such organization, it blesses as well as magnifies its Divine Author.

So Galen, appreciating the adaptive construction of that marvellous instrument, the human hand, felt that in describing its anatomy he was hymning the praise of the Maker.

Volumes have been written, from Ray and Derham to Paley and the Bridgewater authors, filled with striking instances of purposive adaptations of the parts of created complex instruments to the effecting of definite ends. The floodgates of the heart, the valvular structures of the veins, viewed in this light, led HARVEY to conceive, and experimentally to prove, the circulating course of the blood as

their end and object. The exquisite structure of the eye, the transparency of its corneal window, and of the fluids which the light must traverse to strike upon the sentient carpet behind ; the delicately and gradationally adjusted densities of the humours for correcting spherical and chromatic aberration whilst concentrating convergently the luminous rays ; the little circular muscle which, of itself, adjusts the amount of admitted light to the susceptibilities of the retina : in short, the thousand-fold perfections that have exhausted the skill of hundreds of microscopic anatomists ; above all, that intra-cranial structure by which the operations of the visual globe have their destined effect, and the living organism sees—is not all this a manifestation, the which to know and feel must be to praise and bless the Author, and magnify our conceptions of the Divine Power ?

Do not suppose, however, that some special organ of a fully-formed and complex animal has to be selected to exemplify the purposive or adaptive principle in creation: you will find it in the egg, if you have the skill and patience to work out that seemingly simple initiative condition of the animal. To common view, it presents the shell, lined by some layers of thin membrane which you may peel from it, and containing a mass of white slime in which floats a yellow ball or yolk.

Look closely at that ball, and on one side you will see a whitish spot, *a* ; from two other parts, at opposite sides of the yolk, you may discern two opaque thread-



DIAGRAM OF THE STRUCTURE OF THE EGG OF
A FOWL.

like productions, *c, c*, which, as they diverge from the yolk, expand and become lost in the white, *b*. At the larger end of the egg, a little air fills an interval, *d*, between two layers of the lining of the shell,—at least, if the egg be fresh—the common test of which is to apply the tongue to the big end, and the quickly-heated air gives the affirmative reply.

Suppose you proceed methodically in the work of observation : fixing the egg lengthwise, and carefully chipping out a round piece of the shell with its membranes, you will see the yolk floating at the top of the white ; and the first spot I spoke of is at the middle of the upper surface of the yolk. Take as many eggs as you please, turn them about as often as you like, you will always find this opaque white spot at the middle of the uppermost surface of the yolk. Hunter compared this phenomenon to the movements of the needle to the pole. The machinery effecting it is the diverging threads. The yolk is lighter than the white ; these threads are heavier, they are attached to opposite sides of the yolk, and seem to be the axes in which the yolk turns : they are attached, however, below the true axis, on the half opposite to that which bears the spot : sinking as they diverge and expand in the white, they make their half of the yolk the heavier, the spot-bearing half the lighter ; and, as the spot is at the middle of the surface of its hemisphere, it is always uppermost. Now, this spot is the germ in which development of the chick begins, and from which it spreads, under the incubating influence of the mother : the germ is thus brought closest to the hot brooding skin of the sitting hen. The shell is convex and dome-like, to bear her weight. In the course of development, the chick requires to breathe : as the vital fire burns up, organic material is reduced to carbon ; a membrane over which the blood spreads in a network of minute vessels, like a gill or lung, then extends





The Great Ant-Eater. (*Myrmecophaga jubata*.)

from the embryo to the inner side of the shell, between it and the white: the shell is made porous to allow the air access to this temporary respiratory organ; and the oxygen combining with the carbon, it exhales as carbonic acid. As the chick approaches the period of its extrication, it is able to breathe by its proper lungs, and in the 'vesica aëris,' *d*, or collection of air at the great end of the egg, it finds the wherewithal to begin its feeble inspirations, and to utter the low chirp which may be heard just before it chips the shell. And how does it effect this? By means of a hard knob specially formed upon the end of the upper beak, and which, after it has done its work, disappears.

You may think it strange that any mind capable of tracing and comprehending the relations of these structures and their effects—what, in physiology, we term their "uses" or "functions," in the inability to make the matter understood by any other phraseology,—that any competent anatomist should ignore the adaptive relations or the purpose of all these correlated structures! It reminds one, does such a case, of some congenital defect akin to colour-blindness. Some may pity, some may condemn, but no one can comprehend such frame of mind or state of feeling.

Some years ago, there was exhibited in the Zoological Gardens of the Regent's Park an Ant-eater from South America, the first which we had seen there alive. It did not live long, and I dissected it. I show here proofs of the plates illustrative of its anatomy;* at least, of the more characteristic parts. Unlike hairy quadrupeds in general, the Ant-eater, fig. 2, has no teeth; it has a very narrow, almost tubular mouth, with a small terminal opening, capable of allowing a long slender cylindrical tongue to be protruded and retracted. The salivary glands, *c*, were of enormous size, covering all the

* From the "Transactions of the Zoological Society," 1854. 4to. p. 117.

fore part of the neck and upper part of the chest, they

FIG. 2.



TONGUE, SALIVARY GLANDS, AND CLAWS OF ANT-EATER.

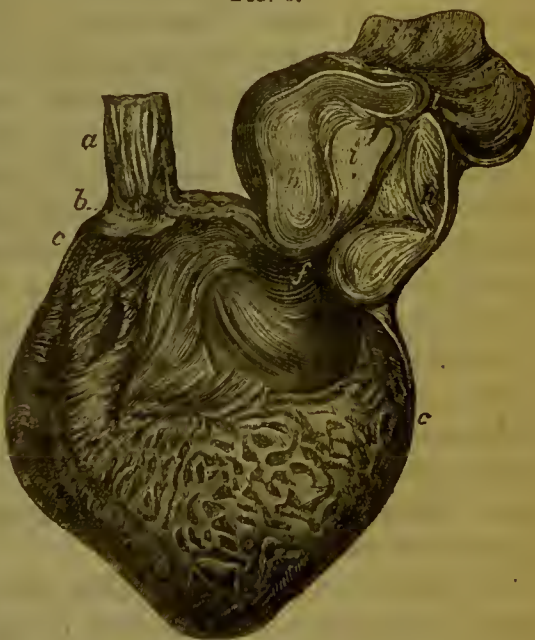
were as big as the liver ; and their ducts conveyed the secretion to a bag, *e*, like a gall-bladder : here, by absorption of the watery part of the saliva, it was made more dense and sticky ; and it was then conveyed to the mouth

to lubricate the tongue—an organ of great length and muscular power. The limbs, especially the fore-paws and claws, of the beast were of great strength.

In its native country, South America, where trees abound, the white ants, chiefly subsisting on decaying vegetable matter, exist in large communities and vast numbers. They make nests, like little castles. The Ant-eater is able to breach with its powerful claws the walls of the fortress. Out, then, rush the myriads of workers and soldiers; whereupon, by rapid movements of the slimed tongue, they are seized and swallowed, scores at a time, by the besieger. But, how, you may ask, are these insects prepared for digestion, there being no teeth?

The stomach is divided into two parts, like a crop, *c*, and a gizzard, *h*: the latter is lined by a thick and hard gristle, *i*; its muscular walls are thickened as in the common fowl; the insects are ground to a pulp, with the help of the sandswallowed with them. The gastric organ of the bird seems to be borrowed by this beast, to compen-

FIG. 3.



STOMACH OF THE ANT-EATER.

sate for a like want of teeth in the proper place—the jaws.

I look upon the tongue of the Ant-eater, with all its con-

comitant mechanism, as having been made, such as it is, for its ant-catching office. I view the huge salivary glands, *a*, *b*, *c*, and their bladders, *e*, as correlated in function with the tongue: the mouth is modified to be a sheath or case for the tongue: the stomach is made a gizzard, because no grinders exist in the mouth. I don't say that the final purpose is the sole condition of what I see; but I recognize it plainly as one, perhaps the chief, cause.

"No," reply the repudiators of design: "we watched the Ant-eater in its confinement; it would eat no ants, it was kept alive on chopped meat and yolks of eggs."

Very true. The ants which our country afford are not termites; they belong to a different order of insects: moreover they secrete a peculiar defensive pungent fluid, abounding in what is called "formic acid." The *Termites* have none of this, but are fat and nutritious, and, doubtless to the *Myrmecophagæ*, savoury morsels. Our *Formicæ* were strange and disgusting to its palate. The instinct of fell hunger led the captive Ant-eater to introduce, as best it might, into its stomach the soft animal nutriment which we provided for it as coming nearest to its natural food. As well say that the legs of a prisoner were not made to run with, because his fetters prevent his moving them.

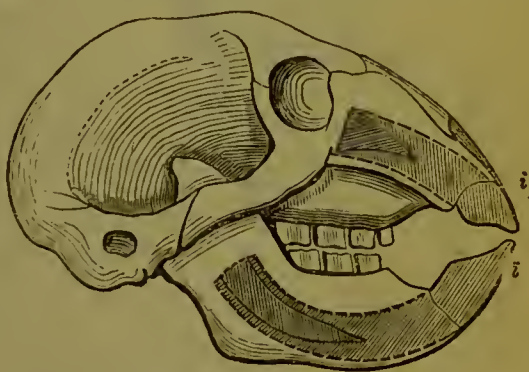
More lately, we have received at the Zoological Gardens a still rarer quadruped, called *Chiromys*, or Aye-aye, from Madagascar. Fig. 4, *Frontispiece*.

This quadruped is stated to sleep during the heat and glare of the tropical day, and to move about chiefly by night in quest of wood-boring larvæ.

The wide openings of the eyelids, the large cornea and expansile iris, with other structures of the eye, are express arrangements for admitting to the retina, and absorbing, the utmost amount of the light which may pervade the forests at sunset, dawn, or moonlight. Thus the Aye-aye is able to

guide itself among the branches in quest of its hidden food. To discern this, however, another sense had need to be developed to great perfection. The large ears are directed to catch and concentrate, and the large acoustic nerve and other structures of the organ seem designed to appreciate, any feeble vibration that might reach the tympanum from the recess in the hard timber through which the wood-boring larva may be tunnelling its way by repeated scoopings and scrapings of its hard mandible. How safe from bills of birds or jaws of beasts might seem such a grub in its teak, or ebony-cased burrow ! Here, however, is a quadrumanous quadruped in which the front teeth (*i*, *ī*), by their great size, strong shape, chissel-structure, deep implantation, and provision for perpetual renovation of substance, are especially fitted to enable their possessor to gnaw down, with gouge-like scoops, to the very spot where the ear indicates the grub to be at work. The in-

FIG. 5.



SKULL AND SECTION OF INCISOR TEETH, AYE-AYE.

instincts of the insect, however, warn it to withdraw from the part of the burrow that may be thus exposed. Had the Aye-aye possessed no other instrument—were no other part of its frame specially modified to meet this exigency,—it must have proceeded to apply the incisive scoops in order to lay bare the whole of the larval tunnel, to the extent at least which would leave no further room for the retracted grub's retreat. Such labour would, however, be too much for the reproductive power of even its strong-built, wide-

based, deep-planted, pulp-retaining incisors, *i*, *ï*: in most instances we may well conceive such labour of exposure to be disproportionate to the morsel to be so obtained. Another part of the frame of the Aye-aye is, accordingly, modified in a singular and, as it seems, anomalous way, to meet this exigency. We may suppose that the larva retracts

FIG. 6.



HAND OR FORE-PAW OF AYE-AYE.

its head so far from the opening gnawed into its burrow as to be out of reach of the lips, teeth, or tongue of the Aye-aye. One finger, however, on each hand of that animal has been ordained to grow in length, but not in thickness, with the other digits; it remains slender as a probe, and is provided at the end with a hook-like claw, 3.

By the, doubtless,

rapid insertion and delicate application of this digit, the grub is seized and drawn out. For this delicate manoeuvre the Aye-aye needs a free command of its upper or fore limbs; and to give it that power, one of the digits of the hind foot is so modified and directed, that it can be applied, thumb-wise, to the other toes, and the foot is made a prehensile hand. Hereby the body is steadied by the firm grasp of these hinder hands during all the operations of the head, jaws, teeth, and fore-paws, required for the discovery and capture of the common and favourite food of the nocturnal animal.

Thus we have not only obvious, direct, and perfect adaptations of particular mechanical instruments to particular functions,—of feet to grasp, of teeth to erode, of a finger to probe and to extract,—but we see a correlation of these several modifications with each other, and with adaptive modifications of the nervous system and sense organs; of eyes, *e.g.*, to catch the least glimmer of light, and of ears to detect the feeblest grating of sound,—the whole determining a compound mechanism to the perfect performance of a particular kind of work.

Our captive *Chiromys*, however, found none of the insects of this country which were offered to it at all suitable to its tastes. And, like the Ant-eater, it preferred another kind of food to starvation, *e.g.*, bread, eggs and honey in milk, with dates and bananas.

A repudiator of the principle of final causes thereupon objects to the evidences of adaptation which have just been shown you, “that they could not have such meaning, inasmuch as the Aye-aye would not feed on insects.” But the very fact in which the objection was based receives its explanation, solely, through teleology.

The native habits and food of the Aye-aye exemplified its operation and purpose in the woods of Madagascar as a check upon the undue prevalence of tree-destroying Xylophagous larvæ. Had the Aye-aye possessed an indiscriminate appetite for insects, it would satisfy such appetite on much easier terms than by gnawing into hard wood for a particular kind of grub. But, as M. Liénard testifies, “il ne voulait pas de larves de tous les arbres indistinctement; il les reconnaissait en les flairant.”* Dr. Sandwith also specifies its favourite large grub, as the destructive Moutouk.†

* Comptes Rendus de l'Académie des Sciences, Institut de France, Octobre, 1855, tome xli., p. 640.

† Transactions of the Zoological Society, vol. v.

The restriction of its likings to the wood-boring kinds insured, and was necessary to insure, the application to their extraction of the efficient instruments with which the Aye-aye had been endowed for the purpose. Thusteleology renders the fact of the non-indiscriminate taste for insects intelligible; the negation of intention and design blinds the mind to the recognition of the significance of the fact, and leads to the more stupid blindness to any meaning or purpose in the co-adjustment of special modifications which renders the *Chiromys* so effective an antagonist to the wood-boring larvæ of the forests it inhabits.

What we have to guard against is this,—the conclusion, that the ways or conditions of the creation of animals are as limited as our powers of comprehending them commonly are and have been.

Man, to gain his purpose, directly constructs and adjusts his artificial machine. God may produce his organic machine, as perfectly and surely, in other ways, to us seemingly leading away from such end. His ways are not as ours.

To give an explanation of my meaning. The skull is a hard, unyielding box, inclosing and protecting a most precious and delicate part of our organization; the cranium is composed of eight bony plates, so constructed, and so connected by what are called “sutures,” dentate and squamate, as to afford, given the amount of dense defensive material, the maximum of resistance to blows. Let me refer you to Sir Charles Bell’s “Animal Mechanics,” published by the Society for the Diffusion of Useful Knowledge, for further particulars and illustrations of the adaptive principle in the human cranial structure.

Well, there is a time when this brain-case must pass through an unyielding passage narrower than the natural diameter of the case at that time. And what do we find to be the structure of the cranium then? Instead of eight, it

consists of eight-and-twenty pieces ; and none of these are fastened or dove-tailed together by the unyielding serrated dentated sutures. Most of the bones can slide over one another. The structure, therefore, admits of the required change of shape, and the soft brain within bears without injury the transitory alteration in the diameters of its case. The final purpose of the structure of the foetal skull has been recognized and expatiated on by all physiologists. But the structure itself relates, and seems to be gained, through another and wider principle. The four pieces of which the occipital bone is composed, and the eight or ten pieces by which the ossification of the sphenoid begins, are found in the cranium of the chick, when it bodily breaks through the shell. The cranium, in it, afterwards coalesces into a single piece ; and there was no call for its subdivision through any such contingency of an earlier period of life, as affects the higher animal.

What we *do* find is, that the skull of all vertebrate or back-boned animals is built up, as a general rule, of the same number of pieces arranged in the same general way ; that these pieces in most cold-blooded vertebrates continue separate throughout life ; and that the plan of their arrangement agrees in the main with that which governs the arrangement of the bones in the segments of the trunk-skeleton ; and that the skull is made up of four such segments. The four pieces of the foetal occipital bone are now acknowledged by all anatomists to be the “body” and parts of the “neural arch” of the last of the cranial vertebræ. And this is the wider or more generalized explanation of the twenty-eight bones of which the human cranium, like that of all beasts and birds, is at first composed, although they afterwards coalesce into eight bones, and sometimes fewer. The law of the development of the skull provides the condition of safety in childbirth.

But this condition is not, therefore, a merely accidental

consequence. We may believe that the Author of the wider law also foresaw its subservience to the narrower purpose, and ordained the "law within the law." Whilst, therefore, expanding insight into the Divine Power as exercised in the Animal Creation has taught us how short and inadequate were the views of it which rested in the appreciation of the fitness of the structure for its function, it by no means gives a ground for the rejection of the foresight and purpose in the properties that make the fitness, although these properties and the concomitant fitness may be the result of the more general principle on which it has pleased the Creator to develop all animal bodies in their progressive degrees of perfection.

The bony segments or vertebræ of both the head and the trunk, although developed according to the common vertebrate type, are modified for express ends and functions in a greater degree in the serpent than in the man. The squamous principle of suture is carried out to an extreme. The

FIG. 7.



SECTION OF CRANIUM OF SERPENT.

frontal, 7, so far overlaps the parietal, 3, and this the occipital bone, 1, that the cranial segments are sheathed one within the other, and the bone in each being of great density and thickness we cannot but discern therein a special adaptation to

the prone position of the serpent, indicative of a provision for the dangers to which it would be subject from falling bodies and the tread of heavy beasts. The whole organization of serpents is replete with such instances of design in relation to the needs of their apodal vermiform character; just as the snake-like eel is compensated by analogous modifications amongst fishes, and the snake-like centipede amongst insects.

Most annotators to Scripture represent serpents as the progeny of a transmuted species, degraded from its original form as the penal consequence of its instrumentality in the temptation of Eve. Thus Drs. D'Oyly and Mant, in the edition of the Bible printed under the direction of the Society for the Promotion of Christian Knowledge (Ed. 1823), write—"The curse upon the serpent consisted, first, in bringing down his stature, which was probably in great measure *erect* before this time: 'upon thy belly shalt thou go,' or 'upon thy breast,' as some versions have it;—secondly, in the meanness of its provision,—'and dust shalt thou eat;' inasmuch as, creeping upon the ground, it cannot but lick up much dust together with its food." Almost every commentator writes under the same impression of the special and penal degradation of the serpent to its present form.* But when the laws of the science of animated nature form part of the preliminary studies of the theologist, he will appreciate the futility of such attempts to expound the symbolic text as if it were a statement of matter of fact.

What Zoology and Anatomy have unfolded of the nature of serpents in their present condition, amounts to this: that their parts are as exquisitely adjusted to the form of their whole, and to their habits and sphere of life, as is the organization of any animal which, in the terms of absolute com-

* "That dust was not the original food of the serpent seems evident from the sentence passed upon the paradisaic serpent, but the necessary consequence of the change made in the manner of its motion."—"Hist. of Serpents," by Charles Owen, D.D., 4to, p. 12. So, likewise, Milton, whose serpent

"Toward Eve
Address'd his way; not with indented wave
Prone on the ground, as since; but on his rear,
Circular base of rising folds, that tower'd
Fold above fold, a surging maze."

"Paradise Lost," book ix., line 495.

parison, we call superior to them. It is true that the serpent has no limbs; yet it can outclimb the monkey, outswim the fish, outleap the jerboa, and, suddenly loosing the close coils of its crouching spiral, it can spring so high into the air as to seize the bird upon the wing: thus, all those creatures fall its prey. The serpent has neither hands nor claws; yet it can outwrestle the athlete, and crush the tiger in the embrace of its overlapping folds. Far from licking up its food as it glides along, the serpent lifts up its crushed prey, and presents it, grasped in the death-coil as in a hand, to the gaping mouth.

FIG. 8.



SERPENT DEVOURING ITS PREY.

It is truly wonderful to see the work of hands, feet, fins, performed by a mere modification of the vertebral column. But the vertebræ are specially modified to compensate by the strength of their individual articulations for the weakness of their manifold repetition, and of the consequent elongation of the slender column.

In our own skeleton, each vertebra is joined to the other by a mass of ligamentous matter connecting two flat surfaces.

It is a much more simple joint than that of the shoulder, where a ball is adapted to a cavity, with the co-adjusted surfaces covered by smooth cartilage, and lubricated by joint-oil, retained and secreted by a synovial capsule. In serpents, every vertebra presents the same beautifully-turned cup and ball, *b*, and synovial capsular joint, as that of our arm; and there are several such between each vertebra: all the joints, moreover, are fashioned to resist yielding, and sustain pressure, in a vertical direction, in which they are most liable to a blow or a squeeze: so that there is no natural undulation of the body upwards and downwards, but only from side to side. So closely and compactly do the ten pairs of joints, *zs*, *s*, *d*, *b*, between each of the two hundred to three hundred vertebræ fit together, that even in the relaxed and dead state the body cannot be twisted except in a series of side coils.

But what more particularly concerns us in the relation of the serpent to our own history is the palæontological fact, that these ophidian peculiarities and complexities of cranial and vertebral organization, in designed subserviency to a prone posture and a gliding progress on the belly, were given, together with their poison-apparatus, by the Creator, to the serpents of that early tertiary period* of our planet's history, when, in the progressive preparation of the dry land, but few, and those only the lower organized, species, now our contemporaries, had been called into existence—before any of the actual kinds of Mammalia trod the earth, and long ages before the creation of man!

Biblical commentators in this matter have erred, knowing

* Constrictors and colubers in the eocene, vipers in the miocene, strata. See "Table of Strata," p. 28.

FIG. 9.

TWO CO-ARTICULATED
VERTEBRÆ, FROM THE
BACK OF A SERPENT.

only, or believing that they knew, the Scripture, and “not knowing the Power of God.”

This admonition of Christ has been needed in all times, and is particularly applicable to the present time.

The early Christians held that Scripture taught the earth to be the chiefest and hugest mass of created matter ; that it was the centre and sole habitable part of the visible universe ; that it was a plain, bounded by water and cloud.

The Book of Enoch, admitted, by the side of Job, into the canon of the Abyssinian church, shows plainly the literal sense in which the movements, attributed to the sun were then understood. The varying lengths of days are explained by Enoch* on the hypothesis of the sun going forth in the glory of a bridegroom from the different eastern windows of heaven, and returning by different western ones, according to the seasons. The idea of the earth as a plain, squared best with the dearest hope and earnest expectation of the early Fathers and their persecuted converts, looking daily for the coming of the Lord, to judge the dead who should rise and, with the living, stand before his judgment-seat.

Great, therefore, and grievous, was the shock which was felt when geometrie reasons for the earth being a ball, and not a plain, began to sway, and to trouble the minds of the more intelligent among the faithful : for, if the earth was globular, one part of its surface might be as fit for life as the opposite ; and how, then, could all men stand before the Judge, “look up and lift up their heads” to Him, if there should be antipodes ? The doctrine of the rotundity of the earth was accordingly denounced as heretieal. We read with astonishment the terms in which it was repudiated by some

* “The Book of Enoch the Prophet,” translated by the Rev. Professor Richard Laurence, LL.D., Oxford. Svo. 1821.

of the Fathers of the Church,—as, *e.g.*, by Lactantius,—at the beginning of the fourth century.*

These exemplary and pious men knew not the Power of God: they thought they knew the Scripture, and they greatly erred. The faithful instruments to whom had been committed the task of making known to man the Creative Power as manifested in the shape of the earth, continued their labours, multiplied their demonstrations, until, at length, the learned and intellectual Augustine yielded.† He warned the more zealous and ignorant of his clergy of the danger of the opposition. This roundness of the earth rests on geometrical data; and, as the mind of man has been created to receive and assimilate truth, it cannot resist such demonstrations. Men, therefore, *will believe* that the earth is rotund; and when ye preach it to be flat, and denounce the new doctrine, they will say, ‘If ye know so little of earthly things, how shall we believe you when you tell us of heavenly ones?’

But more remained and much more remains to know. Copernicus published his work, “*De Revolutionibus Orbium Cœlestium*” in 1543—the year of his death. Half a century later, the telescope of Galileo revealed new phenomena confirmatory and unexpectedly elucidatory of the Copernican theory; Jupiter and his revolving moons realized to actual view, in miniature, the heliocentric doctrine at large. The sad story of the philosopher, “seventy years of age, being of sound mind, and on my knees before you,” (I quote from the Inquisitorial Decree,) “abandoning entirely, as justly ordered, the false opinion that the sun is the centre of the world and immovable, that the earth is not the centre, and that it moves, the said doctrine being declared contrary to Holy Writ,” is familiar and trite. But the Dominicans, with unsparing and systematic means

* *Divin. Instit.*, lib. iii., de falsâ Sapient. Philos., c. 24. The inductive philosopher can no longer be confounded with the wrangling sophists condemned by the Apostle, save in the spirit of sophistry.

† “*De Civitate Dei*,” lib. xvi., c. 9.

to suppress the heresy, were less emphatic in denouncing its impiety than was Luther himself, the vehement Father of Reform.

We learn the convictions of his contemporaries on this question from the following passage of Kepler, the predecessor of Newton, and second only to him in the entrusted task of making known to man the Power of his Maker :—"Holy was Lactantius, who denied the earth's rotundity ; holy was Augustin, who admitted the earth to be round, but denied its antipodes ; sacred is the liturgy of the moderns, who admit the smallness of the earth, but deny its motion : but, to me, more sacred than all is truth." Kepler's "moderns" were the early Reformed Church, which, like every other church of the time, knew not the Power of God as manifested in His Solar System : they all believed they knew the Scriptures, and thus they erred.

It has pleased God that our earth should condense, through its axial rotation, into a spheroid, and that it should not only have the diurnal whirl on its axis, but move in an elliptical orbit about the sun, with other minor conditions of its suspension in space, subject to the universal law of gravitation. I would ask you to reflect upon that property or tendency of the human soul to cleave to truth—to assimilate it, as it were, into the very essence of the intellect, when this has been gifted with the faculties to discern the signs of truth, to search rightly after it, discover and prove it. Copernicus, Kepler, Galileo,—though, in the old man, the flesh was weak before the stake,—knew the certainty of the grounds of their affirmation : then came the crowning demonstrations of Isaac Newton. And a truth has this property, that though it may, and, indeed, as a human possession, must bear but a limited relation to the Infinite Wisdom, yet every successive parcel of knowledge of the Power elucidates and makes more comprehensible and

credible the demonstrated proposition which seemed contrary to the Word.

In regard, for example, to the earth's rotation, the phenomena of the transmission of light from the stars in their apparent position are incompatible with the fixity of the earth. The rays of light take some perceptible time to pass from a star to the earth. The question, therefore, whether the earth be fixed, and the stars move round it from east to west, or whether the earth moves in relation to a fixed star, receives a solution from the now known properties of light, which the Copernicans, or "those few carmen which drove the earth about," as they were contemptuously styled,* were unacquainted with.

Wheatstone's beautiful invention of the revolving mirror, and Foucault's combination of fixed and revolving mirrors, enable us to measure the very velocity of light, and to appreciate it, independently of Bradley's discovery and explanation of the aberration of the stars, which afforded the first visible evidence of the translatory movement of the earth. Astronomical observation thus concurs with the experimental proof of the earth's rotation, in respect to the extraneous evidence thereof afforded by the course of light.

The discovery of the law of gravitation suggested new tests of the shape and motion of the earth. On the hypothesis of the earth's rotation, a place on the equator must move quicker than one at either pole, and heavy bodies should descend with less force at the equator than at the poles. The vibrating pendulum is the instrument by which such force is measurable; and I would recommend you to study the description of the extremely delicate instruments used by Borda and Biot in France, and by Kater, Sabine, and Bayly in England, and their careful and patient methods of experimenting, in order to appreciate the psychological

* Even by Bacon, Discourse "In Praise of Knowledge."

nature of the men whom their Maker has endowed with faculties to make known His Power.

Again, Newton suggests that a demonstration of the earth's diurnal motion could be furnished, if a ball truly turned and carefully dropped from a height should be found not to fall exactly in the perpendicular, but to deviate toward the east. The degree of deviation was calculated, and the theory and the experiment coincided.

Many of you may remember the excitement attending the repetition of those experiments of Foucault, in which the earth's rotation was made visible to the eye by the change of the plane of oscillation of the pendulum.

That beautiful instrument, the gyroscope, yields another striking experimental proof of the earth's rotation, founded upon the fixity of the plane of rotation of a body suspended freely and revolving about one of its principal axes.

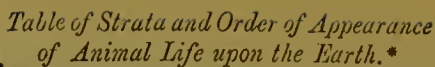
Thus have been established, with a degree of certitude the greatest that the mind of man can rest on, three properties of his dwelling-place,—to wit, its shape, its size actually and in respect of neighbouring orbs, and its motions.

Nearer our time, and proved by a like variety of adequate demonstrations, has been vouchsafed to us a knowledge of the age of the earth,—the certainty, at least, that the date of some six thousand years, assigned to it in some theologies, is inadequate to the work which has been performed on it; and to those to whom a knowledge has been most clearly vouchsafed of the nature of the Divine operations in the preparation and peopling of the dry land, that date is utterly—nay, absurdly inadequate.

The investigations of the various strata, of their composition, of their respective order and mode of formation, and, above all, of the evidences of life which they include, concurrently demonstrate that the globe allotted to man has revolved in its orbit, attended by its moon, through a period

of time so vast, that the mind strains to realize such period by an effort like that by which it strives to conceive the space dividing the solar system from the most distant nebula. The facts so recognized teach, that from the remote period of the deposition of the Cambrian rocks, the earth has been vivified by the sun's light and heat, has been fertilized by refreshing showers and washed by tidal waves ; that the ocean not only moved in orderly oscillations, regulated, as now, by sun and moon, but was rippled and agitated by winds and storms : that the atmosphere, besides these movements, was healthily influenced by clouds and vapours, rising, condensing, and falling in ceaseless circulation.

With such conditions of life, observation of the relics of living beings teaches that life has been enjoyed during the same countless thousands of years ; and that with life, from its beginning, has been death. The earliest testimony of the living thing, whether coral, crust, or shell, in the oldest fossiliferous rock, is, at the same time, proof that it died. At no period has the gift of life been monopolized by contemporary individuals through a stagnant sameness of untold time ; but life has been handed down from generation to generation, and successively enjoyed by the passing multitudes that constitute the species. And not only the individual, but the species goes ; and, just as death is met by birth, so extinction has been balanced by creation,—i.e., by a concomitant and continuous operation of Creative Power, which has produced a succession of species ; and, furthermore, that in this succession there has been “an advance and progress in the main.” So true is that text of Christ—“*Pater meus usque modo operatur, et ego operor.*” (John v. 17.) “My Father worketh hitherto (*ἄρτι, usque modo*, to this time), and I work.” We discern no evidence of pause or intermission in the creation or coming to be of new species of plants and animals.



* Taken, by permission of the publishers, from Owen's "Palæontology," Svo. A. and C. Black, Edinburgh.

Such is the sum or condensed expression of exact and oft-repeated observations by adequately gifted seers, working diligently and patiently for the truth, in this field of the Divine operations ; and not in one country only, but in all the chief parts of the world.

It is not the fruit of mere speculation ; no mazy web spun by a busy, teeming brain, out of some one ill-comprehended fact or mistaken statement of phenomena, like a Whiston's or a Burnet's "*Theoria Sacra Telluris*:" it is the result of concurrent testimonies of keen surveyors of the terrestrial operations of that Power, to whom the surveyors themselves, their powers, periods, and opportunities of surveying, and of truly reporting their surveys, are alike due.

The knowledge so gained of the age of our globe parallels in importance that of its shape, its size, and its motions. The contrast between such knowledge and the belief of Lactantius and Luther on these latter terrestrial properties is as great as that between their idea of the time of the world's creation and the certitude on this point possessed by the geological interpreters of the Creative Power with gifts akin to those of Copernicus, Galileo, and Kepler.

I may say that between the conception of past time which a knowledge of God's operations therein on our earth imparts, and the dates of the beginning of those operations in the Jewish (A.M. 5623) and Romish (A.M. 5869) calendars for the present year, the difference is as great as between the astronomers' conception of the sky, and the notion of those men of Shinar who thought to reach the azure dome by building high enough their Tower of Babel !

As the discoveries of the geometer have expanded our views of space, so those of the geologist have of time.

The vista of the theatres of life through long ages past ; the successive series of plants and animals—vital wave

following vital wave,—of forms all strange to present time, but constituting gradational and correlative groups in their own time ; the evidences of the share which vitality has taken in forming the crust of the earth ; to know, to try to realize the fact, that every bit of coal once moved as sap in the vessels of a plant, and that each cliff and “bushless down” of chalk, and every quarry of limestone and marble, once circulated in the vascular system of an animal ;—what can surpass such views of the Creative Power, or more inspire due reverence for the Wielder ! They are as impressive as the views that meet the instructed eyes of him who passes in gaze from planets to fixed stars of varying magnitude, and with the telescope divides the reciprocally revolving pair of suns which distance blends together, and resolves the nebulous cluster of remoter orbs !

Did time permit, I could open out to you another field of the Power of God, as manifested in the Law of the Geographical Distribution of Plants and Animals, and show you how the peculiar life-forms, for example, which now respectively characterize South America, Australia, and New Zealand are closely allied to or identical with the forms represented by fossils that characterized those parts of dry land before Niagara began to cut back its channel in the platform of rock over the face of which, when uplifted 50,000 years ago, it first began to fall ; and such knowledge is incompatible with the notion of the divergence of all existing, air-breathing, or drownable animal species from one Asiatic centre within a period of 4,000 years.

But to how many in this Hall might such bodies of fact and inference be distasteful,—such enlargement of their knowledge of the Power unwelcome ? May I suppose that there are any here who would arrest the course of Science if they could—would gladly fetter its diffusion ? If so, gentlemen, consider, that such state of mind and feeling, so far as it can

have sway, must be added to those other "Obstacles to Progress" on which the noble Earl now guiding the Foreign Affairs of this country eloquently addressed you in the Introductory Discourse of 1855. Lord Russell then told you—"Some there are who shut their eyes to one truth, lest it should impair another they deem more sacred. But one truth can no more quench another truth, than one sunbeam can quench another sunbeam. Truth is one, as God is one."*

I would add, that, of two plainly contradictory propositions, one only can be true: they cannot be harmonized. The attempt at reconciliation cannot be made without detriment to the moral sense and nature of him who sets about a work oftentimes more akin to the special pleading of the scribe, than to the truth-loving, trustful simplicity of the disciple of Christ.

I would fain believe that there are not among the representatives of the Christian world whom I am now honoured in addressing, any to whom the expositions of the Power teaching the world's vast age, the co-relation and concomitancy of death with life, the unintermittance of creative acts, may be abhorrent: who look with suspicion, dislike, or dread upon the evidences, reasonings, proofs, of Geology, Palæontology, Geographical Zoology: who have ears to hear and will not listen, who have eyes to see and will not behold. But, if such there be, let me remind them, that their mental condition is the same as that of the devout Christians, when the discoveries of the shape, the motions, and cosmical relations of our small planet were first propounded. They know not, or they refuse to receive, the later evidences of the Power of God: they think they know the Scriptures, and they do err.

* "The Obstacles which have retarded Moral and Political Progress." A Lecture by the Right Hon. Lord John Russell, M.P. 12mo, p. 25.

When listening to a pastor, teaching, *e.g.*, from the texts, "Since by Man came death,"* or "As in Adam all die,"† that the physical death of all the lower creation—beasts, polypes, plants—was the consequence of the "fall," it has seemed to me that the preacher was holding the same carnal view of the "death" of which the Apostle wrote, as did the Rabbi of the "birth" of which Christ spake, when the "master of Israel" was privileged to hear from a greater Master the condition of entering the kingdom of heaven. "How can a man be born again?" asked Nicodemus; "can he enter a second time into his mother's womb?"

We know that the birth unto righteousness is a spiritual birth; and may not, must not, the death unto sin relate to that principle which alone can sin?

Yet even Milton,‡ with most of the theologists of his age,§ took the carnal view. They accepted the text as to the date and cause of the death of the lower creatures in a literal sense: they thought they knew the Scripture; they knew not the Power of God as it is now made known, and they erred.

May we not discern, I would ask, the hand of Providence in the successive floods of light thrown upon the operations of which this earth has been the seat?

A Copernicus, a Newton, a Cuvier,—is not an accident. Ought we not to acknowledge a gracious purpose in the

* 1 Cor. xv. 21.

† 1 Cor. xv. 22.

‡ "A Treatise on the Christian Doctrine," &c., translated by Charles R. Sumner, M.A. (now Lord Bishop of Winchester.) 4to. 1825. "All nature is likewise subject to mortality and a curse on account of man."—P. 278.

"Even the beasts are not exempt. The bodily death originated in sin, and not in nature."—P. 279.

§ See, however, CURCELLÆUS, Inst. III., 13-21, maintaining that temporal death is the result of natural causes, and that eternal death alone is due to sin.—Sumner's Note, p. 279.

making known according to the ways, and by the instruments He now chooses, so much of His Power as may be elucidated by interpreters of the records in the stony rocks?

Call to mind the speculations in which some good men have indulged and gone astray on prelapsarian paradisaical conditions; such as, "the lion lying down with the lamb," and even being of like peaceful herbivorous habits. Hear the truth! Not only has death ever followed life in pre-Adamitic plant and beast, but also, and commonly, death by violence. Of old, and æons ere so high a creature as man trod the earth, it was a scene of conflict and carnage. The evidence abounds of mutilation and wounds, and the healing of wounds and fractures, in the old fossil animals.

For the variety, the beauty, the polish, the sharpness, the strength, the barbed perfection, the effectiveness in every way, of lethal weapons, no armoury can compete with that of the fossil world.

Nor are the instruments of defence less remarkable: the spines of thousands of the more peaceful fishes that were the prey of the fiercer sorts—both alike extinct,—these ichthyodorulites, as they are termed, alone require a book for themselves for adequate illustration in our Palæontological records.

Here, therefore, we see again how needful it is, for the avoidance of error, that a knowledge of the Power should be combined with the study of the Scripture.

Not but that, for all that is essential to the right life here and the life to come, Scripture alone sufficeth: the eternal truths are plainly told. Christ condescends to the humblest intellect; the ploughman may understand that which will make him wise unto salvation as clearly as the philosopher.

It is the human element mingling with the Divine, or meddling with it, which the discoveries of science expose;

it is the fence set up about some narrow and exclusive view which they break down.

Beware, therefore, of logically precise and definite theologies, accounting, from their point of view, for all things and cases natural and preternatural, claiming to be final and all-sufficient.

"Systems of Doctrine," "Schemes of Christianity," "Dogmatic Formularies," are of human fabrication, the works of man's brain, of which he is as proud and jealous as of the works of his hands. They, forsooth, must not be meddled with; any ray of light exposing a hole or a bad joint in them must be shut out,—the light-bringer, perhaps, anathematized: they must be the exception to the common lot awaiting all mortal constructions!

Beware, also, of theological terms ending in "ist" and "ism:" for the most part, they indicate a lack of Christian charity in the more ignorant of two insufficiently informed disputants, who, under a disability to meet an argument, explain away a fact, or reconcile opposite propositions, flings at his opponent some hard word so terminated.

Search the Scriptures with a mind as free from preconception as may be possible to a finite and imperfect nature,—free, especially, from any system which may have been built up by the wit or wish of man through selection or adjustment of the Divine utterances. Emancipate yourselves from notions of textual meanings which may have been early impressed upon your plastic understanding; clear away the film or medium which has been systematically screwed upon your mind's eye by your early teacher, with best intentions and in best faith, whether Anglican or Athanasian, Lutheran, Wesleyan, Presbyterian, &c. As much as may be, become again "as little children," in seeking guidance from Holy Writ. Above all, square your actions by Christian ethics; and be assured that, as you do so, the essential truths

will become plainer to your intellect ; for “ He that doeth of the will shall know of the doctrine, whether it be of God.”

And now it only remains to me to add, that the main practical aim I have had in view in accepting and working out my present task, has been to recall to my fellow-Christians some of the experience of the past,—to entreat them to be guided thereby—to put more faith in, or at least to exercise more forbearance towards, those who, entrusted with the talent of discovery, labour under the sense of responsibility for its use.

Has aught that is essentially Christian suffered—have its truths ceased to spread and be operative in mankind,—since physical doctrines, supposed or “declared contrary to Holy Writ,” have been established ? Cease, then, to take alarm at each new ray of light that dawns upon a field of the Divine Power, till now dark to our comprehension : for, be assured, there remain many others yet to be illuminated by His predestined instruments. The light, bright as it is, contrasted with the darkness it has dispersed, penetrates but a short way into the illimitable theatre of the operations of Infinite Power. The known is very small compared with the knowable.

Alay, then, your fears, and trust in the Author of all truth, who has decreed that it shall never perish ; who has given to man a power to acquire that most precious of his possessions, with an intellectual nature that will ultimately rest upon due demonstrative evidence.

